

Nemorhaedus goral.

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Nemorhaedus (Smith, 1827)

- Naemoredus* Smith, 1827:352. Type species *Antilope goral* Hardwicke, 1825. Proposed as a subgenus, recognized as a genus, and spelling revised to *Nemorhaedus* by Hodgson (1841).
Kemas Ogilby, 1837:138. Type species *Antilope goral* Hardwicke (1825).
Caprina Wagner, 1844:457. Included six species, one of which was *A. goral* Hardwicke, 1825. Preoccupied by *Caprina* Mathéron, 1843, a mollusc.
Urotragus Gray, 1871:372. Type species *Antilope caudata* Milne-Edwards, 1867.

CONTEXT AND CONTENT. Order Artiodactyla, Suborder Ruminantia, Family Bovidae, Subfamily Caprinae, Tribe Rupicapriini (Corbet, 1978). Sokolov (1953) placed *Nemorhaedus* in its own tribe, Nemorhaedini, that included *Capricornis* (serow), but excluded the rupicaprines *Rupicapra* (chamois) and *Oreamnos* (mountain goat). The genus *Nemorhaedus* contains one species, *N. goral* (Allen, 1940; Corbet, 1978; Dolan, 1963, 1970), which is followed here. However, some authors consider there to be two species, *N. goral* and *N. cranbrookii* (Corbet and Hill, 1980; Nowak and Paradiso, 1983; Zhang, 1987). Volf (1976) stated on the basis of external, physiological, and craniometric differences, that *N. caudatus* is a distinct species, separate from *N. goral* (only *griseus* and *raddeanus* subspecies were used in his study). Groves and Grubb (1985) suggested that there are six species (*N. goral*, *N. baileyi*, *N. caudatus*, and three species from the genus *Capricornis*). Soma et al. (1987) stated that *Nemorhaedus* is separate from *Capricornis*, although closely related; it is difficult to determine how many species are in the genus. Honacki et al. (1982) indicated that *N. baileyi*, *N. caudatus*, and perhaps *N. cranbrookii* also are valid.

Nemorhaedus goral (Hardwicke, 1825)

Goral

- Antilope goral* Hardwicke, 1825:518. Type locality "the Himalayah range and the mountains of the Nepal" [Nepal].
Antilope duvaucelii H. Smith, 1827:352. Type locality unknown.
Antilope caudata Milne-Edwards, 1867:377. Type locality probably in the the Burgeja Mountains, Heilungkiang, China.
Nemorhedus griseus Milne-Edwards, 1871:93. Type locality Tibet, China.
Antilope (*Naemoredus*) *cinerea* Milne-Edwards, 1874:362. Type locality Tibet, China.
Kemas arnouxiensis Heude, 1888:3. Type locality Chekiang, southeastern China.
Kemas henryanus Henry, 1890:93. Type locality "the gorges and glens near Ichang," Hubei [Hupeh], China.
Kemas raddeanus Heude, 1894:240. Type locality Amur River area, Heilungkiang, China.
Kemas niger Heude, 1894:241. Type locality probably Chenkouting, Sichuan [Szechwan], China.
Kemas fargesianus Heude, 1894:241. Type locality Chenkouting, Sichuan, [Szechwan] China.
Kemas galeanus Heude, 1894:243. Type locality Yu Ho Mountains, southern Shaanxi [Shensi], China.
Kemas viduanus Heude, 1894:243. Type locality Yu Ho Mountains, southern Shaanxi [Shensi], China.
Kemas xanthodeiros Heude, 1894:243. Type locality eastern Sichuan [Szechwan], China.
Kemas iodinus Heude, 1894:243. Type locality eastern Sichuan [Szechwan], China.
Kemas pinchonianus Heude, 1894:243. Type locality Sichuan [Szechwan], China.
Kemas initialis Heude, 1894:244. Type locality Chenkouting, Sichuan [Szechwan], China.

- Kemas versicolor* Heude, 1894:244. Type locality Chenkouting, Sichuan [Szechwan], China.
Kemas curvicornis Heude, 1894:244. Type locality Chenkouting, Sichuan [Szechwan], China.
Kemas aldridgeanus Heude, 1894:244. Type locality "Yi-tchang," Hubei [Hupeh], China.
Kemas fantozatianus Heude, 1894:245. Type locality Mountains of "Kiuntcheou," right bank of Middle Han, Hubei [Hupeh], China.
Urotragus bedfordi Lydekker, 1905:83. Type locality probably Dharmasala, Himalayas.
Urotragus evansi Lydekker, 1905:83. Type locality Pokokku district, Arakan, Burma.
Naemoredus hodgsoni Pocock, 1908:195. Type locality "Sikhim" [Sikkim].
Nemorhaedus baileyi Pocock, 1914:32. Type locality "Dre on bank of Yigrong Tso (Lake) in Po Me, 9,000 ft.," Tibet, China.
Nemorhaedus cranbrookii Hayman, 1961:319. Type locality "at 8,000 feet in the Adung Valley, Upper Burma."

CONTEXT AND CONTENT. Context as given in generic summary above. There is no agreement to the number of valid subspecies (Allen, 1940; Corbet, 1978; Dolan, 1963, 1970; Nowak and Paradiso, 1983; Soma et al., 1987; Volf, 1976). The division of the gorals into species and geographic races is difficult for they show few distinguishing characters when series are compared. Generally accepted subspecies are (Allen, 1940; Dolan, 1970):

- N. g. arnouxiensis* (Heude, 1888:3), see above (*henryanus* Henry, *aldridgeanus* Heude, and *fantozatianus* Heude are synonyms).
N. g. caudatus (Milne-Edwards, 1867:377), see above (*galeanus*, *raddeanus*, and *viduanus* Heude are synonyms). Radde (1862) incorrectly supposed his animal to be the same as the Japanese "*Antilope crista*" (= *Capricornis*). Radde's specimen is the type of *N. g. caudatus* (Allen, 1940).
N. g. goral (Hardwicke, 1825:518), see above (*duvaucelii* H. Smith and *bedfordi* Lydekker are synonyms).
N. g. griseus Milne-Edwards, 1871:93, see above (*cinerea* Milne-Edwards, *baileyi* and *hodgsoni* Pocock, *niger*, *fargesianus*, *xanthodeiros*, *iodinus*, *pinchonianus*, *initialis*, *curvicornis*, and *versicolor* Heude, *cranbrookii* Hayman, and *evansi* Lydekker are synonyms).

DIAGNOSIS. Gorals are smaller and osteologically distinct from the serow (*Capricornis* sp.; Allen, 1940). Gorals are the smallest of the rupicaprines. Shoulder height ranges from 570 to 711 mm (690 to 785 mm in the USSR, $\bar{X} = 730$, $n = 8$, (Nasimovitch, 1955); 570 to 610 mm, $\bar{X} = 580$ for males and 601 for females of "*cranbrookii*," $n = 9$; Zhang, 1987). Mass is approximately 22 to 35 kg (Primose, 1911; $\bar{X} = 25$ for males and 29 for females of "*cranbrookii*," $n = 7$; Zhang, 1987). The horns are short (127 to 178 mm is typical, but 235 mm is known). For "*cranbrookii*" ranges for males = 125 to 160 mm, $\bar{X} = 145$, and for females, range = 118 to 150, $\bar{X} = 136$, $n = 6$ (Zhang, 1987). There is a small preorbital gland; the goral lacks the large, acute depression on the lacrimal that is distinct on the serow. The maxillaries have lost contact with the nasals on the lateral edges, so that the nasals are supported only by their proximal ends (Fig. 1). The molars and premolars are similar to those of the serow except that the teeth are smaller and the buccal surfaces of the premolars in the upper jaw are nearly smooth, without the vertical ridges at anterior or posterior corners (Allen, 1940). Second and fifth lateral metacarpals are present instead of just the fifth as in the serow (Allen, 1940).

GENERAL CHARACTERS. Length of head and body is approximately 820 to 1,300 mm; length of tail is 76 to 203 mm. For "*cranbrookii*" length of body averages 953 mm for males and 987 mm for females, and length of tail averages 108 mm for males



FIG. 1. Dorsal, ventral, and lateral views of skull, and lateral view of mandible of adult male *Nemorhaedus goral* (American Museum of Natural History 39329) from Sichuan, China. Greatest length of cranium is 173 mm.

and 109 mm for females (Zhang, 1987). The goral has a short, woolly undercoat, covered by long, coarse guard hairs (Fig. 2). Males have a short, semierect mane, except in "*cranbrookii*" (Zhang, 1987). Coloration varies from buffy gray to dark brown to a bright foxy red to tawny buff. There usually is a white patch on the throat and a dark dorsal stripe. Females have four mammae. Pedal interdigital glands are present as are glands behind the horns (Sokolov et al., 1982), but there are no inguinal glands. Measurements of the skull (in mm) are (Allen, 1940; Geptner et al., 1961; Volf,



FIG. 2. Photograph of mature *Nemorhaedus goral* at San Diego Zoo (by E. M. Mead).

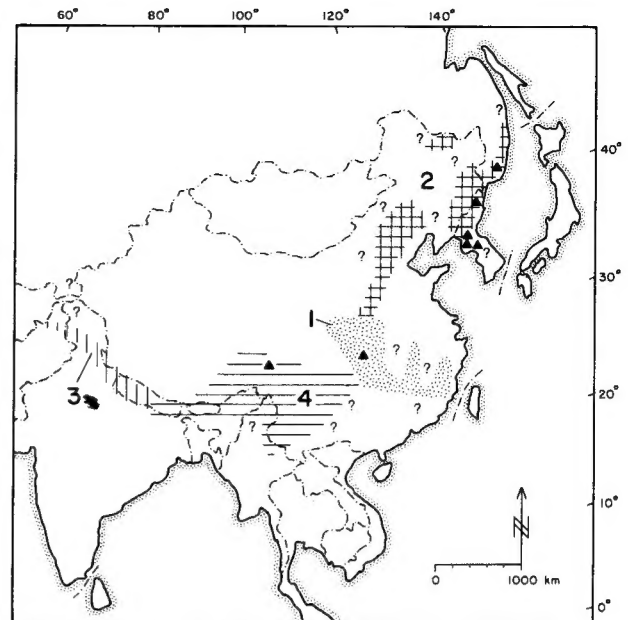


FIG. 3. Present geographic distribution of *Nemorhaedus goral* in Asia and the location of the fossil sites (triangles). Subspecies are: 1, *N. g. arnouxiensis*; 2, *N. g. caudatus*; 3, *N. g. goral*; 4, *N. g. griseus*. Illustration by E. M. Mead.

1976): condylobasal length, 164 to 230; zygomatic breadth, 90 to 102; width across molars, 58 to 63; length of upper molar row, 62 to 71. The following cranial measurements (in mm; presented as mean and range for males and females, respectively) are for "*cranbrookii*" (Zhang, 1987): length of cranium, 202, 189 to 210, 206, 195 to 205, zygomatic breadth, 91.3, 87 to 95, 90.5, 86 to 95, length of upper tooth row, 60.7, 54 to 68, 62.5, 59 to 66, length of horn core, 85.3 ($n = 4$), 76 to 95, 55 ($n = 1$), and diameter of horn core, 21.8, 19 to 23, 15.5, 15 to 16.

DISTRIBUTION. Gorals presently occur only in Asia (Fig. 3). The Swat Province of northern Pakistan presently is the westernmost locality for the goral, with the main surviving population in the Indus Kohistan mountainous region (Roberts, 1977). Dolan (1963) indicated that *N. g. goral* extends into the Russian territory (Tadzhikskaya), but this record appears not to be substantiated recently. From the Neelum Valley of Kashmir, gorals are distributed east along the southern foothills of the Himalaya Mountains in India and in Nepal, through Sikkim, Bhutan, Assam, and into northernmost Burma and Thailand (Hayman, 1961; Lekagul and McNeely, 1977; Lydekker, 1907; Pocock, 1914; Prater, 1965; Roberts, 1977; Schaller, 1977, 1980).

The western extent of the distribution in China is in southeastern Xizang (Tibet), where the species lives in the Bomi-zayu subregion of the Oriental zoological division (Bailey, 1913; Feng et al., 1981; Zhang and Zheng, 1981; Zheng et al., 1981). Distribution of gorals throughout central and eastern China apparently is changing rapidly, although they live in most provinces of the country (Dolan, 1963); they occur in Hunan, Sichuan, Fujian, Shaanxi, Shanxi, Hebei, Xizang, Hubei, and Yunnan, but are absent from Nei Mongol (Allen, 1930, 1940; Dolan, 1963; Geptner et al., 1961).

The northern distribution of gorals occurs from Manchuria (Heilongjiang and Jilin) into North Korea (present southern extension in Korea is unknown) and on into the coastal mountains of the Sikhote-Alin' range of southeastern Siberia. Presently, gorals are found in the Sudzhinsk and Sikhote-Alin' reserves, but have been extirpated from the area adjoining the Bureinsk Range within the last century (Nasimovitch, 1955). The goral is considered rare in the USSR and is restricted in distribution (Voloshina et al., 1976). Where they do occur, gorals appear to be most common along the steep cliffs adjacent to the ocean up to 1,000 m elevation (Nasimovitch, 1955).

FOSSIL RECORD. Seven locations with fossils of *Nemorhaedus* are reported in Asia (Fig. 3). Colbert and Hooijer (1953) recovered *N. goral* from karst-sinkhole deposits of middle-Pleistocene

cene age at Yenchingkou, near Wanxian in Sichuan Province, China. Arambourg and Fromaget (1938) reported gorals (*N. cf. cinereus* and *N. cf. edwardsi*; of unknown validity) from lower Pleistocene deposits of Tam Nang, China. The most recent review of paleontological-anthropological localities in China indicates that no new localities of the goral have been reported since the Yenchingkou finds (Aigner, 1978a). *Nemorhaedus* is thought not to be found in direct association with early human remains in China, although a few questionable remains were found with hominid remains at Choukoutien Locality 1 (Aigner, 1978b).

The upper-Paleolithic deposit in Suchan Cave, southeasternmost USSR, contains 150 remains of "*N. caudatus*" (= *N. g. caudatus*; Vereshchagin and Ovodov, 1968), and is the only reported fossil site of the goral in Siberia (Vereshchagin and Baryshnikov, 1980; Vereshchagin and Kuz'mina, 1984). Sohn (1984:883) reported goral remains from four Korean localities of "third interglacial and fourth interglacial periods" (Tonggwangjin, Tokchon Cave, Chougchong-am Cave, and Haesang Cave), all associated with pollen of *Juglans*, *Abies*, *Pinus*, and *Thuja*. Gorals also were reported from the Holocene age Korean localities of Sopo-hang, Najin-po, and Pomui Kusok (Sohn, 1984).

The goral may be the most primitive of the living rupicaprids (Geist, 1985). The oldest remains of *Nemorhaedus* seem to be of early Pleistocene age (Tam Nang, China; Arambourg and Fromaget, 1938), but the actual chronological placement of these remains needs re-evaluation and refinement. Possibly the ancestor to *Nemorhaedus* is the European goral, *Gallgoral* (*G. meneghinii*; Guérin, 1965), that lived in France, Italy, Spain (Schaub, 1922), and possibly elsewhere in Europe during the early Pleistocene (Villafranchian land mammal age, Olivola faunal unit; Azzaroli, 1983). *Gallgoral* was 50% larger than the present *Nemorhaedus* (Kurtén, 1968). Savage and Russell (1983) indicated that a goral, "*N. ? melonii*" (Kurtén, 1968; as *Capricornis melonii* in Geist, 1987) apparently occurred in Sardinia either during the middle-Pleistocene or in the last post-glacial period; the stratigraphic position of the find is not clear. Skeletal remains of a supposed goral, *Nemorhaedus palmeri*, were described from "Pleistocene" deposits of Colorado; however, these supposedly were found to belong to a modern bighorn sheep, *Ovis canadensis* (Miller, 1930).

It is generally agreed that the Rupicapriini were ancestors of the Capriini, and that separation occurred during the middle Miocene (Robinson, 1986). *Oioceros* (Miocene age) resembled *Nemorhaedus* in size and in the small pointed horns (except for the anticlockwise twist in *Oioceros*; Pilgrim, 1939, 1947). By the early Pliocene, an animal (*Tussumnoria*) described as skeletally between *Nemorhaedus* and *Capra* was in China. *Pachygazella grangeri* of the Pliocene of China was considered the first true rupicaprine (Pilgrim, 1939; Schaller, 1977). However, the tribe Rupicapriini may have had a Mediterranean origin (Robinson, 1986). Teilhard de Chardin and Young (1931) believed that *Pachygazella* does not belong to the nemorhaedine group. At present it is not certain whether *Nemorhaedus* gave rise to *Capricornis* or the reverse (Soma et al., 1987), although the two are closely related (Robinson, 1986).

FORM AND FUNCTION. Color of pelage varies greatly with locality. The most common color is gray; browns and yellows added form various shades of: grayish brown, dark brown, dark yellow, ashy gray, yellowish brown, and bright foxy-red (Allen, 1930; Dolan, 1970; Hardwicke, 1825; Hayman, 1961; Lekagul and McNeely, 1977). Most have a white to white with pale-ochreous bordered throat patch (Allen, 1930; Dolan, 1970). Some forms have a distinct black dorsal stripe (Dolan, 1970; Hayman, 1961; Pocock, 1914). The winter pelage is coarse, with guard hairs 67 mm long and the underfur 25 to 30 mm long. The summer coat is similar but shorter and more sparse (Geptner et al., 1961). Dental formula is $i\ 0/3, c\ 0/0, p\ 3/3, m\ 3/3$, total 30. Geptner et al. (1961) indicated that the dental formula is 32, with the occasional addition of a lower canine.

ONTOGENY AND REPRODUCTION. Sexual maturity is reached in the second or third year, but mating seems not to occur until the third year (Bromlei, 1956; Dobroruka, 1968). Rut begins in the period from late September to November in the far north and from early November into December in the south (December for "*cranbrooki*," Zhang, 1987). Myslenkov and Voloshina (1978) found that 85% of copulations were in November, with estrus lasting 20 to 30 h. Gestation lasts approximately 180 days. Normally, only one kid is produced, although two can occur, especially in

captive populations (Dobroruka, 1968). Females when accompanied by young tend not to aggregate. Kids are born between April and May and stay with the mother for about 1 year. Some captive gorals live longer than 17 years (Nowak and Paradiso, 1983). Rathore and Khera (1982) summarized causes of the death of 18 gorals in Indian zoological parks. These causes were: one, taeniasis parasitic disease; eight, pneumonia; six, gastroenteritis; one, hepatitis; and two unknown.

ECOLOGY. *Nemorhaedus* typically are found in rugged, wooded, mountainous terrain at elevations of 1,000 to 4,000 m. Gorals in Pakistan are found in the sclerophyllus forest zone, a subtropical pine community between 940 and 2,000 m elevation. Here, gorals live in a plant community of *Pinus roxburghii*, *Quercus incana*, and *Berberis*. In Punjab Province the goral ranges from 820 to 1,500 m elevation. Gorals in Swat Province frequent precipitous cliffs up to 1,950 m elevation (Roberts, 1977). In China along the southern slopes of Mount Qomolangma, gorals are found in evergreen-broadleaf forest from 1,800 to 2,500 m elevation (Zhang et al., 1981). Gorals in northern Burma occupy elevations from 1,100 to 2,600 m in montane-broadleaf forests and conifer forests (Feng et al., 1981). "*Cranbrooki*" is reported to live in mountain forests from 2,000 to 4,500 m elevation in southern China (Zhang, 1987). In Langtang National Park, Nepal, gorals are found from 1,680 to 3,350 m elevation (Green, 1981). In other regions of Nepal, gorals occur in *Betula* forests to timberline (about 4,000 m elevation). Schaller (1977) found gorals in Nepal most common at elevations from 2,500 to 3,000 m in areas of cliffs and small meadows.

The diet of *N. g. caudatus* is widely varied consisting of graze and browse species; seasonal changes in diet are known (Bromlei, 1956; Schaulskaya, 1980; Valova, 1978). Gorals in northern Pakistan principally subsist on grazing the tussocks of grass (*Aristida*, *Apluda*, and *Themeda*; Roberts, 1977). "*Cranbrooki*" graze on sunny, grassy slopes, feeding mainly on *Usnea* and other lichens and grasses (Zhang, 1987). Nasimovitch (1955) found gorals to be tree and shrub browsers (evergreen herbage, broadleaf trees, and shrubs as principal foods) during winter months. Gorals feed in the morning and late in the evening.

The parasites, *Haemaphysalis* (*H.*) *goral* and *H. (Allophylis)* sp. are known to occur in adult stages on the goral (Hoogstraal, 1970; Hoogstraal and Wassef, 1979). "*Cranbrooki*" were always found with *Ixodes* sp. (Zhang, 1987).

Gorals are considered endangered (Berger et al., 1979; Voloshina et al., 1976). However, in parts of Nepal, they are still fairly common (Green, 1981).

BEHAVIOR. Gorals associate in small groups of 12 or fewer individuals during most times of the year. Seasonal migrations usually are <2 km in steep, rocky regions (Nasimovitch, 1955). During summer months in the USSR, gorals usually do not travel >1 km from the steep sea cliffs (Nasimovitch, 1955). Gorals do not move or take flight until the intruder is almost upon them. When in flight, they often bound away uphill, with long leaps in an irregular pattern; they are expert climbers. Gorals at rest tuck their legs under the body and head, with the neck directed forward flush against the ground, making concealment effective.

During the mating season, males may occupy and mark territories of from 22 to 25 ha by means of the glandular secretion on rocks and vegetation. In southeastern USSR, gorals form no harems, and each male mates with no more than six females (Myslenkov and Voloshina, 1978). Vocalization is reported as only a hissing alarm snort.

Gorals never seem to dig for food during winter months, but push snow away from grass stems and shrubs, with their muzzle when snow is <5 cm deep. When not feeding, they conceal themselves under overhanging rocks, in caves, or in brush. Gorals avoid walking in soft snow >25 to 30 cm deep, due to their short legs. In snow deeper than 35 cm, gorals leave belly marks and travel awkwardly; in snow depth of >50 cm, they flounder (Nasimovitch, 1955).

GENETICS. Wurster (1972) reported a diploid number of 55 chromosomes for "*cranbrooki*" and *N. g. griseus*. Soma et al. (1980, 1987) in a sample of one male and one female goral, *N. g. griseus* and "*cranbrooki*," found that both possessed one unpaired submetacentric and one acrocentric chromosome, involved in a Robertsonian system, and reported a $2n = 56$. Soma et al. (1987) report

a $2n = 56$ for *N. g. caudatus*, *N. g. goral*, "*raddeanus*," and *N. g. arnouxiensis*. In a comparison of chromosomes of rupicaprids, *Nemorhaedus* (FN = 56) was most similar to *Capricornis sumatrensis* (Sumatran serow, FN = 58, this is now considered an error, FN = 60; Soma et al., 1987) and dissimilar to *C. crispus* (Japanese serow), *C. swinhoi* (Formosan serow), *Oreamnos americanus* (mountain goat), and *Rupicapra rupicapra* (chamois), all with FN = 60 (Soma et al., 1981). NORs (nucleolar organizer region) are present in *Capricornis* only in the long arm of No. 4 metacentric. NORs in *N. g. raddeanus* were present on Nos. 1, 4, and 10, and in *N. g. arnouxiensis* on Nos. 1, 3, 4 metacentrics (Soma et al., 1987). NORs hint at close relationship between *Nemorhaedus* and *Capricornis*, but they are separate entities and require further analyses (Soma et al., 1987).

Nemorhaedus g. griseus and "*raddeanus*" (= *N. g. caudatus*) were part of a breeding study at the Prague Zoological Garden, Czechoslovakia. The two forms produced sterile offspring, therefore, are suspected to be distinct species (Volf, 1976).

REMARKS. The etymology of the generic name is *nemoris* (Latin, genitive: a grove or forest) and *haedus* (Latin: a young goat), therefore *Nemorhaedus* refers to a goatlike animal and its habitat in forested regions. The species name, *goral*, is a local name for the animal from northeastern India (Gotch, 1979).

One of the problems surrounding the goral is the correct spelling of the generic name. Smith (1827) placed the goral (then in the genus *Antelope*) in his newly created subgenus *Naemoredus*. Smith (1827:352) did not indicate the etymology of his new taxon, but he stated that members of the group do have "a caprine form" and that they "reside in mountainous and woody regions." The first spelling by Smith (1827) is an apparent misspelling (International Code of Zoological Nomenclature, 1985; Article 32c). It appears that Hodgson (1841) was the first revisor of the group and used the spelling *Nemorhaedus*, which is the correct form.

As an endangered species and one that is apparently decreasing in its distribution, the goral needs to be studied in its native habitat. Much of the range is presently limited by humans and apparently is being reduced by overexploitation of the goral's habitat. The following zoos are known to house the goral: Beijing Zoo, Shanghai Zoological Garden, China; Japan Serow Center, Gozaisho Alpine Zoo, Japan; Kathmandu Central Zoo, Nepal; Prague Zoological Garden, Czechoslovakia; San Diego Zoo and Wildlife Park, USA. The Chinese forms are the least known, but are the most abundant and most widely distributed. Most knowledge of the species is from the small, relictual populations in southeastern USSR.

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